ON THE

CONSTRUCTION OF IMPROVED

ORDNANCE,

AS PROPOSED IN A LETTER TO THE

SECRETARIES OF WAR, AND OF THE NAVY, AND THE CHIEFS OF THE BUREAUS OF ENGINEERS, AND OF ORDNANCE, OF THE UNITED STATES.

BY

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CAMBRIDGE:
WELCH, BIGELOW, AND COMPANY,
PRINTERS TO THE UNIVERSITY.
1862.

ADVERTISEMENT.

The following letter was forwarded to the five officers of the United States Government to whom it is addressed, on the day of its date. It was sent in a printed form for their more ready perusal. As no notice whatever has been taken of it, the writer now lays it before the public, and especially before the members of the Congress of the United States. He has endeavored to state in the briefest possible form all that relates to himself, personally; and he now asks attention to the subject only in so far as it derives importance in relation to the *National Defences*, and as an investigation in a subject of practical science.

Cambridge, January 28th, 1862.

CAMBRIDGE, Dec. 23, 1861.

To HON. SIMON CAMERON,
SECRETARY OF WAR,
HON. GIDEON WELLES,
SECRETARY OF THE NAVY,
GEN. JOSEPH G. TOTTEN,
CHIEF OF THE BUREAU OF ENGINEERS,
COL. JAMES W. RIPLEY,
CHIEF OF THE BUREAU OF WAR ORDNANCE,
CAPT. A. A. HARWOOD,
CHIEF OF THE BUREAU OF NAVY ORDNANCE.

GENTLEMEN: —

IN the year 1840, I determined to attempt the construction of cannon of wrought-iron, following certain theoretical principles which I had long held under consideration. I then had under my control a small forge and machine-shop, and several skilled workmen. I commenced upon three and four pounder guns, of which I made three, and subjected them to such proofs as satisfied me that the principle upon which I wrought was true, and that it might be carried into successful practice, beyond a mere experiment. To do this, however, required engines and tools of an elaborate and costly kind, and some assurance that the guns produced would be adopted by the government. To obtain this assurance, I went

to Washington, and after interviews with the Secretaries of War and the Navy, Messrs. Spencer and Upshur, and the ordnance departments under their control, I obtained a contract, from the former, for six or eight 6-pounder field guns, and from the latter for four light 32-pounders. Returning then to Boston, I commenced erecting a building with furnaces and tools for the proposed manufacture. All this involved a large outlay of money, and the devotion of some part of every day for nearly three years. It was not, therefore, until the year 1843 that my first contract for the six-pounder army guns was completed. But these guns being finished and proved to the entire satisfction of the then very able Chief of Ordnance, Colonel Talcott, I commenced upon the larger navy guns. A full year was taken up with this and some six or eight others of the same caliber, made on my own account. These likewise endured not only the contract tests, but those of a much more severe character to which I determined to subject them. A short account of the manufacture of these guns was published by me in 1845, and circulated both here and in Europe. I need not enumerate the steps by which the foregoing work was accomplished, nor the particulars of expenditure connected with it. I will only say that the outlay of my own money, and that of a few gentlemen pecuniarily connected with me, was more than seventy thousand dollars, and that over sixty thousand remains unreturned.

Although I had thus produced stronger and better guns than had ever before been made by man, I failed to obtain that government adoption without which it was impossible for me to go on. The War Ordnance Board indeed offered to order a few batteries of field guns. But my chief reliance had always been upon the Navy. To substitute these light guns, though of great caliber and power, for the old and ponderous cast-iron guns, would, I thought, be an advantage so evident that it must be taken into favor. In this I was mistaken; and although my cannon was a complete success in all that related to its construction, it was an utter failure as regards its adoption by the government. That it was successful as a construction, I have only to say that Sir W. Armstrong, twelve years after I was obliged to abandon it, and after learning, as I fully believe, the method by which I produced it, formed his rifle cannon upon the same plan,* and I defy him now, with the whole patronage

* When I first read an account of the method followed by Armstrong in constructing his gun, although I saw at once the exact resemblance of it to the method invented by me in 1840 – 44, yet not being aware of the fact that the specification of my English patent had been published *in extenso*, I thought it might be that Armstrong had re-invented my form of gun and the machinery required to produce it. But since writing this letter I have looked into that great work, "The English Printed Specifications," a copy of which is in the Boston Library; and I there find, that the specification of my English patent, enrolled July 5th, 1844, No. 10,013, was printed in 1854. This patent was taken out in the name of Thomas Aspinwall, then American Consul at London, who acted as

of the British government, to produce a more perfect gun, so far as *strength*, *soundness*, and *finish* are concerned, than I produced seventeen years ago by private means alone. I limit my boast to the above enumerated particulars, for as to Armstrong's inventions in rifling and breech-loading, he deserves in my opinion much credit for them, and I hope that I shall be the last man to deny to another all that belongs to him. Although I was thus obliged to suffer the loss and shame of defeat, and to abandon all that I had done, the mechanical theories upon which I had wrought, and developed in practice, had made a strong lodgement in my mind. I had early seen that the

my attorney. The specification was written by me, and transmitted, complete, to him. It occupies twenty-one large printed pages, with full references to elaborate drawings, which occupy a large folio plate, of the machinery used by me in constructing the cannon. Any one acquainted with what Armstrong calls his gun, and the mode of constructing it, will find here everything relating to it so far as its structure, *without rifling and breech-loading apparatus*, is concerned. There is no difference whatever in the form of the construction, the mode of putting the rings together within the furnace, or the tools and enginery required for the work, except the substitution by Armstrong of a steam hammer for the hydrostatic press used by me.

Now, Armstrong has shown, by his denunciation of patents, to the British Association, that he is well read in the record of them, is it then probable that this has been overlooked by him? And will the high-minded and honorable men, the English engineers, especially those who constitute the Institution of Civil Engineers, suffer this plagiarism, or piracy, taking whichever of these ugly words may best describe the act, to pass unchallenged in England?

principal objection made to adopting my cannon lay in its price, and in the skill and attention that must always be required in its manufacture. To obviate these I proposed to myself to form a cannon of a thin cast-iron body surrounded by several layers of wrought-iron or steel hoops, placed upon it under *great strain.* I determined, by calculation, that this would be nearly, perhaps quite, as strong as my abandoned form, would come within the reach of ordinary skill, and would be in the long run cheaper than the ordinary cast-iron gun.

Thwarted as I had been by most of the government officials and government boards, I had no heart to move in this matter practically at any great expense. Indeed, I had not the means to permit me to do it, and I had already led others to spend more, from their confidence in my representations, than I chose to do again. No other course seemed open to me but to secure the invention by patent, publish an account of it with an exposition of its principles, ask the government to adopt it, and wait the event. Early in the year 1855 I determined to adopt this course, and in June of that year I completed my specification and drawings for a patent. In September I commenced writing an account of its structure and a demonstration of its strength. This account, although finished in November, was not, owing to several unforeseen hindrances, published until the beginning of 1856. As soon as it was printed, I sent copies of it to all

the military and naval posts and stations, and especially to the ordnance officers at Washington. I likewise wrote a letter to the chief of the Ordnance Bureau, calling his attention to it, stating, amongst other things, that it must soon come up and be adopted in Europe, — that it must be taken up here in the end; — why not, then, commence now, and have the credit, if any credit should come of it, of leading the way in it, rather than be driven by others to the use of it? To this letter no answer or acknowledgment was ever returned.

Again, two years after this, the rifled cannon made its appearance in England. To carry this out, Armstrong, as I have said before, constructed his gun after the method used by me eighteen years before. It now seemed to me that it would give us a great superiority over all the European forms of rifled cannon to apply the principle of the rifle-ball to cannon constructed after the method last proposed by me. So strongly was I impressed with this idea, that in February, 1860, notwithstanding my age and feeble health, I made the journey to Washington to urge it upon the authorities. I found them all as torpid as to any of the improvements of Europe, in rifled cannon, as they were to improvements in naval matters in the Sandwich Islands. I obtained, after a long and *im*-patient waiting, an interview with the Secretary of War, Floyd. He treated me courteously, though I saw at once, that he knew nothing, and

cared nothing, about rifled cannon. But as he requested me, on taking my leave, to put the substance of the statement which I had made to him in writing, I did so, on my return home, and forwarded it to him. This completed my intercourse with him, though I afterwards printed my letter, a copy of which is herewith enclosed.

Here the matter has rested so far as applications from me are concerned. In the mean time the country has become involved in a great and trying contest, without any adequate provision of guns, either in number, or kind, such as the contest requires. Being about to move in again urging the propriety of adopting the gun which I have so many times heretofore proposed for adoption, I have been informed that all other plans of large cannon, at least, are to be given up, in favor of a gun brought out by Captain Rodman of the Ordnance. A detailed account of this gun is contained in a series of Reports made by Captain Rodman, of his experiments, performed, through a number of years, and at a very great expense to the government, and now printed in a very costly form, but not published, in the usual sense of that word. The experiments had for their ultimate object the improvement of cast-iron ordnance, and more especially to prove the value of a method, devised by Captain Rodman, of cooling the gun from its fluid state. To accomplish this, he restores the old method of casting the gun upon a

core, and passes through the axis of this core a stream of cold water. The purpose of this is to produce a more perfect equilibrium of the particles of iron than they possess when the cooling is performed from the outside surface, as is the case when guns are cast solid. This seems to be a good method for casting large guns, and the few experiments that have been made upon proving, to extremity, guns cast in this way show in its favor. He produces, after all, but a cast-iron gun, and the labors of others, upon other materials, have established the fact that cast-iron guns and round shot are soon to give place to another generation, formed of a different material and upon an entirely different plan. But of this I shall speak hereafter.

The first question now is, whether Captain Rodmon's experiments, and the deductions drawn from them, are trustworthy. Now, the whole superstructure which he lays out, and proposes to raise, depends upon an instrument which he has constructed for determining, as he supposes, the actual force of the fluid produced by fired gunpowder under almost all possible circumstances, and the power of cast-iron guns to resist the force thus created without being destroyed by it. This instrument is at once the compass, quadrant, and chronometer by which he is guided in his voyage of discovery. It is described particularly at pages 174 and 175, with a good plate annexed. Plates of it are given likewise in some

modified form, in several other places. In speaking of it here, therefore, I shall suppose that the reader has Captain Rodman's book before him, open at page 174, and that he understands the structure and working of the instrument, as there set forth.* Let us, then, see whether the instrument will perform what is claimed for it. First, then, it is said that the indentation or impression made by the blunt or diamond-shaped point indicates the *pressure* of the fired gunpowder; that it acts by *pressure* purely, as a heavy weight acts when placed slowly upon a support, and not by a blow, as the same weight will act when suffered to fall through some sensible space, and certain facts are adduced at page 178, to sustain this view. I shall not stop here to show the fallacies

* This instrument and its use will be understood by any engineer or intelligent mechanic from the following description. Suppose a row of six small holes to be drilled through the side of a cannon, into its caliber. These holes are placed 14 inches apart, and, commencing near the breech, extend to near the muzzle, or a distance of 84 inches. The instrument consists of a small but strong iron frame, having a shank or plug forged upon one of its sides. This plug is $1\frac{1}{2}$ inches in diameter and $1\frac{1}{2}$ inches long, and is formed into a screw, the thread of which corresponds with a similar screw-thread cut into the outer portion of each of the holes in the side of the gun, by which means the frame may be secured to either of the holes, at pleasure. A small hole is bored through the axis of this plug, making a free passage to the caliber of the gun. A piston is nicely fitted to this hole in the plug, and thus the end of the piston receiving the whole force of the fired gunpowder will be driven outwards at each discharge. A large steel head or block is fitted upon the outer end of the piston, and from this head rises a py-

of these supposed analogies, but appeal first to the direct teaching of a simple experiment. Take, then, a little spring balance, such as is used at some of the post-offices for weighing letters, and which consists of a little pedestal and column, like a candlestick, which contains a spiral spring, and over the top is the pan, to hold the thing to be weighed. Now take any weight that will carry the pan just down to the top of the column when slowly applied. Half of this weight will carry the pan half-way down, if applied in the same way, but if you add, to this half weight, a small quantity, just enough to overcome the friction of the acting parts, and hold this upon the pan when at its full height, so as just to touch its surface, and then release it *suddenly*, the pan will descend to the top of the socket, or will mark twice

ramidal or lozenge-shaped point, or blunt edge. Against this edge, and firmly fixed in the frame, is a piece of thick copper. Now when the gun is fired, the piston, being driven outwards, forces this dull point or edge into the copper, and leaves a mark or impression upon it corresponding in depth to the force with which the piston was driven against it. By comparing an impression, made in this way, with another impression made upon another piece of copper by the actual pressure of weights placed upon a similar tool, Captain Rodman supposes that the force of the piston may be estimated very nearly. The reader will perceive, on reading a little farther in the text, that the force of the point, by which the impression is made by the instrument, is not the equivalent of the pressure upon the caliber of the gun, and that it was a gross oversight in Captain Rodman to consider them as equals. It will, of course, be understood, that, when one of the holes is used by the instrument, the others are closed by screw-plugs made to fit them.

the weight that it actually possesses. The cause of this must be so apparent to any one well acquainted with the laws of moving forces that I shall not stop to explain it here. Yet the action of the weight here is perfectly analogous to the action of Captain Rodman's instrument, or that part of it which is moved by the powder to make the impression, namely, the indenting tool, the block upon which it rests, and the little piston which receives the force of the powder. The mass of matter of which these are constituted is *fired* against, or into, the copper, as much as the ball is fired out of the muzzle of the gun. The analogy with the experiment of the spring balance is this: the indenting tool and its appendages are pressed forward by the gunpowder. The weight upon the spring balance is pressed down by gravitation. These pressures change the inertia in both cases into living force. This living force accumulates during the motion, from the gravitation in the weight, and the powder pressure in the gun, being, through the first half of the space, twice as great as the mean force of the resistance of the spring in the one case, and the copper in the other; and this accumulation is displayed in overcoming the resistance during a space equal to that first passed over.

We see, then, from the analogy of the weight falling upon a spring balance, that Captain Rodman's instrument ought to display and register double the force which he applies to it; even if it acts as freely

and undisturbedly as a spring balance, it cannot make less than a double register. But we shall see by and by that this is but a small part of the actual error; and yet Captain Rodman takes its register as true to within 1,000 pounds in cases, which he supposes to have been of pressure, of 90,000 or 100,000 pounds. He seems, indeed, to have had no suspicion of any error when his instrument gave indications of force wholly incompatible with the strength of the materials to which it was applied. Thus, at page 197, he takes the force which acted upon it at 100,000 to the square inch. Now the instrument in this case was held to the gun by a screw, formed into the cast-iron body of the gun, $1\frac{1}{2}$ inches in diameter and $1\frac{1}{2}$ inches deep. This gives an area of the *plug* of the instrument of 1.75 square inches, which received the full pressure of the fired powder. The pressure upon the end of the instrument then was $1.75 \times 100{,}000 = 175{,}000$ pounds, or about 80 tons. He must be a very bold engineer who would sleep under a weight of 10 tons suspended over him by a bolt tapped into a hole, in a cast-iron plate of $1\frac{1}{2}$ inches in diameter and $1\frac{1}{2}$ inches deep, and yet it does not seem to have occurred to Captain Rodman that 80 tons' pressure must have driven his instrument from its place.

But let us go a step further. Captain Rodman, at page 192 *et seq.*, relates a course of experiments which may be given in short hand as follows. He

made 18 cylinders of three different kinds of iron. They were all one foot long, and all bored out through their entire lengths with calibers two inches in diameter. They were then turned off on their outsides, so as to leave them of six different thicknesses, varying from each other from half an inch up to three inches. The variation being, of course, by increments of half an inch. Each kind of iron gave one cylinder of each thickness. The mean strength of the iron, as ascertained from specimens of each casting, being 26.866, say 27,000 pounds per square inch. These cylinders were then subjected to a bursting force produced by firing gunpowder confined within them. This was done for the purpose of ascertaining the power of cast-iron of these different thicknesses to withstand the force thus produced. The force was measured, by Captain Rodman's instrument, of course, and the first two columns in the following table give the strength of each thickness of metal according to Captain Rodman's mean:—

½	37842	25541
1	38313	38313
1½	63384	46057
2	80229	51085
2½	92270	54732
3	93702	57468

Upon seeing the enormous strength thus given to the iron, Captain Rodman merely remarks that the

bursting pressures are greater in the whole series than required by the tenacity of the iron, "even supposing the whole thickness of metal to resist uniformly as in tensile strain." But no doubt seems to cross his mind as to the accuracy of his instrument or his measures; he therefore proceeds forthwith to compute the force on the hypothesis "that the strain diminishes as the square of the distance from the axis increases." This means to reduce the power of the metal to sustain pressure, at different thicknesses, according to Barlow's formula. I have given his numbers in the third column above.

I confess I was puzzled for a long time to find out what these numbers meant. The tenacity of the iron used was 27,000 pounds to the inch; Barlow's formula gives for a cylinder 2 inches internal diameter and 1 inch thick, made of such iron, just half of this tenacity, or 13,500 pounds. I then went over all the different thicknesses according to Barlow's formula, and found even stronger cases of discrepancy than that here cited, and as I do not profess to be a mathematician of a very high order, while Captain Rodman has the calculus "familiar as his garter," I thought it was possible, after all, that I had misunderstood Barlow's rule. I therefore, laid down, in section, each of the cylinders in full size, and reqested three of the distinguished mathematicians of Cambridge to tell me, what must be the strength of each according to Barlow's rule. They all calculated separately, and

all agreed with each other and with me exactly, and I here give the whole matter in a tabular form.

1st column in this table, gives the thickness of the several cylinders.

2d column, the pressure per square inch, as measured by Captain Rodman's instrument, under which each cylinder burst.

3d. The pressure which the cylinders ought to have sustained according to Captain Rodman's computations, from Barlow's formula.

4th. The true pressure of burstings according to Barlow's *formula* as computed and applied by me, on iron having 27,000 pounds per inch, tenacity,—this being the mean tenacity of these specimens, as stated on p. 192.

5th. The errors of Captain Rodman's experiments, or, of his instrument.

6th. The errors of Captain Rodman's computations.

1	2	3	4	5	6
$\frac{1}{2}$	37842	25541	9000	28842	16541
1	38313	38313	13500	24813	24813
$1\frac{1}{2}$	63384	46057	16200	47184	29857
2	80229	51085	18000	62229	33085
$2\frac{1}{2}$	92270	54732	19286	72984	35446
3	93702	57468	20250	73452	37218

[NOTE.—The reader is requested to attend particularly to the 5th and 6th columns of this table, as these give the errors of the instrument, and of the computations.]

Now how is all this? Why, Captain Rodman in his computations took, not the coefficient of the true tenacity of 27,000, as laid down by Barlow, but the tenacity which his instrument gave for the cylinder one inch thick. Thus taking at 38,313 what should have been 13,500. Not only so, but the law of the inverse square, which he used, and which is Barlow's rule, makes it impossible that any of his last instrumental measures should be nearly right, even if the tenacity be increased from 27,000 up to 76,626, which is the number that he in fact uses. For, according to this law, a cylinder of two inches' internal diameter, made of cast-iron, or any *unmalleable* material, of 76,626 pounds' tenacity, can never be made thick enough to sustain a pressure of 76,626, or at least it cannot be done until some one shall contrive to make $1 \times x = 1 + x$, or 1 multiplied by 1 equal to 1 added to 1, a feat which Captain Rodman's instrument must have performed in giving several of the results above tabulated.

I do not think it will be necessary to pursue this instrument any further to show its utter worthlessness. It must be given up, and the whole family of results born of it must go with it.*

* I shall be excused for citing one other case, although it may be thought, by some, unnecessary. Captain Rodman gives at page 197, in his table, the force produced by firing 12.67 pounds of powder in an 11 inch gun, behind a shot of 186.4 pounds weight, at, in one instance, 100,000 pounds. Now this must have given a *bursting* pressure upon the walls of the gun of 1,100,000 pounds to every

I shall pass, therefore, from Captain Rodman's instrument to an examination of his gunpowder. When the newspapers, some time ago, gave the story of Captain Rodman's experiments with his 15-inch gun, there was a great account made of the strange kind of gunpowder used, the grains of which were said to be as big as pigeons' eggs. But Captain Rodman's book gives us the reason for the use of this very coarse powder. It is to avoid the great stress laid upon the gun by the rapid development of the gas or fluid, as produced by powder of common grain, from its quick combustion. Now, Captain Rodman proposes, by the slow combustion of these large lumps, not only to avoid the shock of the first explosion, but to continue the development of the force through the whole length of the bore. This would certainly make it much easier work for the breech portion of the gun; but the

inch of its length; consequently, if the gun was 11 inches thick, the iron to sustain this pressure must, if Barlow's formula be true, (and Captain Rodman makes no doubt of that, but uses it under the name of the inverse square,) have possessed a tenacity of 150,000 pounds to the inch. Not only will no cast-iron bear this strain, but no metal, nor any other substance whatever yet known to the art of man, is capable of bearing it. Even cast-steel, the strongest body known, when wrought down by the best hammering, will not sustain 150,000 pounds to the inch. Indeed, if a mass of iron gun-metal, though the strongest ever made, were cast as large as the Capitol at Washington, and then bored through with a caliber of 11 inches, it would, according to Barlow's formula, be split by a fluid pressure of, not 150,000, but 50,000 pounds to the inch.

fact of resorting to it shows the suspicion entertained by Captain Rodman of his gun's strength.

Let us, then, first see how far the idea of equalizing the pressure is obtained by increasing the size of the grain. To do this, I must resort to the measures given by Captain Rodman's instrument, which, though worthless as absolute measures, may yet give some rude approximation to comparative values when used upon the same gun and upon the same place, but with different grained powders. Turning to his book, then, p. 203, we find that a charge of 8 lbs. of powder grained to .1 of an inch diameter, gave against a 43-lb. shot a force of 51,800 lbs., 14 inches from the breech, and 6,700 lbs. at the distance of 84 inches, — these being the greatest and least forces; while a charge of 8 lbs. of powder of .4 inches' grain, or 64 times the former in size of grain, gave against the same shot 31,950 lbs. for the greatest, and 5,150 lbs. for its least force. The greatest force of the fine powder, then, was about 7 times that of the least force; while the greatest force of the coarse powder was about 6 times that of the least force. Surely this is no great advance in equalizing the forces between the breech and the muzzle of the gun. But let us see what it costs in loss of force from the use of the coarse powder. Taking the mean of these two extremes, as the true force in both cases, we have $51{,}800 + 6{,}700 \div 2 = 29{,}250$ for the mean force of the 8 lbs. of fine

powder, and $31,950 + 5,150 \div 2 = 18,550$ for the mean force of the large powder; from which it will be seen that it will require $12\frac{1}{2}$ lbs. of the coarse powder to produce the same force upon the shot that is produced by 8 lbs. of fine powder. The long and short of this whole matter of using the powder in lumps rather than grains, is a *mechanical adulteration*, and produces the same effect, namely, a slow combustion, such as may be produced by making the powder of materials *chemically adulterated*, or by mixing a portion of clay with the paste, or by moistening good powder before using it. This reduction of force may be carried to any extent by increasing the size of the grains or lumps, or by making it in *perforated* cakes, as Captain Rodman actually proposes to do.

But suppose that Captain Rodman's ideas of the advantage of a slow development of the force could be carried out, of what use would it be? I assert, although I am not yet quite prepared with a formal demonstration of it, that the same, or very nearly the same, quantity of iron will be required in the gun, the iron being used in the manner pointed out by me in 1855, to give the same velocity to a given shot, under whatever law the force is developed, between the limits of the quickest powder now used, and one of equable force development; and that, to produce this force with the least expenditure of powder, the development of the force should be made as quick as possible.

I now pass to an examination of Captain Rodman's proposal to use hollow shot. Having, as it seems to me, laid his powder under as great a contribution as it would bear, to avoid putting too much stress upon his gun, he proceeds to put the same tax upon his shot, and he assesses it by taking 9 inches from the heart of every 15-inch shot, thus reducing its weight from about 425 pounds, to about 320 pounds. In the mediæval times, when guns and gunnery were in their infancy, stone balls were used. The lightness of this material saved the imperfect *bombards* from destruction. The effect of these balls was of course very small, compared with the heavy, solid iron shot, brought into use in a later age. Are we to return to the mediæval practice? This certainly seems a step in that direction.

Sir Howard Douglass, in speaking of the terrible effect of the fire of the American frigates in the war of 1812, says that some of them used shot weighted by a leaden core. This I believe is not true, but it shows the opinion of this old engineer, of the advantage that might be expected from increasing rather than diminishing the specific gravity of cannon-shot. Yet Captain Rodman's hollow shot seems to be looked to, pp. 289, 307, as the missile to meet iron-plated ships. Whether it is intended to explode them against the ship, or to depend upon their direct percussion, is not very clearly stated. The effect would probably be very much alike in both

cases. Indeed, Captain Rodman admits, p. 298, that, although "none of these broke in the gun, some did break in the sand-bank after the sand had been packed hard by repeated firing." God forbid then, that we should ever have to try them against the sides of the Gloire or the Warrior.

I have thus examined some of the prominent points in the labors of Captain Rodman, as they are detailed in his reports, and, without, as I hope, making any remark disrespectful to him as an officer and gentleman, I have declared freely what seems to me the value of the most important of the experiments and conclusions given in his work. Repeating here what I declared in an earlier part of this paper, that I think well of his method of cooling the hollow casting which is to form a gun; I think that there is good reason to believe that these guns will be somewhat superior to those made in the usual method. In the practice of casting in this way, however, great care must be observed to avoid the explosion which may occur should the cooling water find its way from its conductor into the body of the mould.

But, after all, what chance has any cast-iron gun, especially smooth-bore gun, to stand before the kind of gun proposed by me in 1855, if that be once adopted and executed in the rifled form? It might have been said when this plan was first promulgated, its principles pointed out, and its advantages demonstrated, that, however perfectly I had tested, by prac-

tical trial, the superiority of my guns, made twelve years before, of wrought iron and steel, no such practical test had been made upon the peculiar form last proposed. This objection can now no longer be made. If I have been prevented, or denied the opportunity of giving the practical test myself, others have partially done it for me. This has been effected, first, by Captain Blakely, an able and scientific officer of artillery, in England, who filed a specification there, soon after the date of mine, for an improved gun upon the same principle that is given by me. He did this no doubt from his own original conceptions and, although he failed in his first trials, probably from want of practical knowledge, yet he soon after constructed a gun having a few hoops, only, upon the breech, which he claims to have been the strongest gun ever made. His claim was thus carried to terms a little too high, from his not remembering, perhaps not knowing, the strength of my 6-pounder wrought-iron guns, made fifteen years before. However this may be, no one now doubts the great strength of his guns, as they are called in Europe.

Again, Mr. Whitworth, who has carried on such a sharp opposition to Armstrong, uses hoops strained on to the body of all his large wrought cannon.

So, at last, in this country, Mr. Parrott has *reinforced* his cast-iron rifled cannon with a wrought-iron hoop shrunk upon the body of the gun, between the breech and the trunnions, and by this imperfect or

partial application of a form and principle which I have taken so much pains to develop, he alone has succeeded here in producing an effective rifled gun. The legal right of Mr. Parrott to use this piece of my structure will soon be submitted to the proper tribunal.

Last of all, and what must be considered as decisive of the merits of the principle of imparting strength by the strained hoop, the Spanish government have lately published the report of a commission appointed to take the whole subject of rifled cannon into consideration, and decide upon the question of which is the best form. This commission, after a thorough and laborious investigation, gives its decision clearly and decidedly in favor of the hooped gun, under the name of Blakely's gun, over all others. A printed account of this report, from the Scientific American, is herewith transmitted.

Permit me then, Gentlemen, in conclusion, most respectfully, but earnestly, to urge your attention to, and adoption of, the principles and method of making cannon proposed by me, and demonstrated to be the most perfect method which has been devised to obtain the greatest strength and endurance for these great instruments of war.

I am, Gentlemen, very respectfully,

Your most obedient servant,

(Signed,) DANIEL TREADWELL.

[Note.—I cannot conclude, without asking the scientific engineers of the country, if they are willing that a work like this, which I have examined, shall be taken by other nations, and by posterity, as giving a representation of the practical science of the United States in the year 1861? But as it is printed at the public expense, and with the *imprimatur* of a high official board, it will be taken as such, unless its errors, of which I have struck at a few of the more prominent ones, are pointed out to, and if possible disavowed by, those who ought never to have suffered the work to appear under the stamp of official approbation.]